

# **CALTRANS APPROVED TITLE 21 TRANSACTION RECORD TYPE CODES**

## ***BACKGROUND***

In 1990 the California State legislature directed the California Department of Transportation (Caltrans) to develop specifications and standards for an Automatic Vehicle Identification system such that a vehicle owner would not have to install more than one device to use toll facilities statewide.

Caltrans developed open compatibility specifications for a two way communications protocol for Automatic Vehicle Identification including an initial set of Transaction Record Type codes mandated for statewide electronic toll collection use. This standard was Chaptered into the California Code of Regulations in 1992 as Title 21, Chapter 16, Articles 1 through 4, and is commonly referred to as "Title 21".

The Title 21 standard envisioned more complex Transaction Record Type codes being developed for both electronic toll collection and other new applications. To maintain the growth of Title 21 it was specified that Caltrans shall function as the standards monitoring authority to authorize the use of new record types and to assign record type numbers to newly authorized records.

## ***INTENT***

This document represents the current Caltrans approved Transaction Record Type codes.

## ***APPROVAL HISTORY***

Following is the Approval History of Title 21 Transaction Record Type codes.

	DATE	REQUESTOR	APPROVER	DESCRIPTION
1	7-27-92	Caltrans	California Code of Regulations	Reader and Transponder compatibility specifications with an initial set of Transaction Record Type codes defined for electronic toll collection in California.
2	1-31-97	Texas Instruments	Caltrans	Numerous additional Transaction Record Type codes approved involving lane specific, data transfer and other manufacturer specific information. Message Types were created to further define information exchange.

## ***CALTRANS TECHNICAL CONTACT***

David Cordone, PE

Traffic Operations

Office of ITS Projects and Standards

Email: david\_cordone@dot.ca.gov

Telephone: (916) 653-4670

## **DEFINITION OF TECHNICAL TERMS**

<b>Alternative Polling:</b>	A synchronized process where a Reader checks to see if a transponder has arrived by alternatively using a Reader Polling Message with a different Transaction Record Type code.
<b>Approved Codes:</b>	Title 21 Transaction Record Type Codes that have been approved by the California Department of Transportation.
<b>Data Element:</b>	A formalized representation of information. Elements are combined to form a message to provide the information defined by the Transaction Record Type codes.
<b>Data Registration:</b>	A process where the format of all data elements is collected and compiled so that different data assignments remain unique and functionality is defined. It also provides the foundation for regional and interregional interoperability.
<b>Half Duplex:</b>	Data can be transmitted in both directions, but not at the same time.
<b>Message Types:</b>	Message types in this document are used to further define the function and information exchanged between the reader and transponder during each stage of the half duplex communication scheme. There are currently three types defined for the Reader Polling, Transponder Data and Reader Acknowledge messages. The "message types" are specific to this document and do not represent message types (e.g. in Title 21, Type 1 is a poll message) identified in the Title 21 standard. The "type" discrepancy will be clarified in a future Title 21 standard amendment.
<b>Polling:</b>	A synchronized process where a Reader checks to see if a transponder has arrived.
<b>Protocol:</b>	A set of rules or conventions formulated to control the exchange of data between two or more entities.
<b>Reader:</b>	A system, typically in a fixed location, that triggers or activates a transponder, polls the transponder for specific information, and provides an acknowledge message to the transponder after a valid response to the polling message has been received.
<b>Reader Acknowledge Message:</b>	The third and final step in a half duplex communication scheme. Provided to inform specific transponders that they have been successfully processed and can be used to terminate the transaction, or continue processing. It is a specific response to a Transaction Record Type code transmitted during the Transponder Data Message.
<b>Reader Polling Message:</b>	The first step in a half duplex communication scheme. Tells the transponder the type of transaction the reader wishes to conduct by transmission of a Transaction Record Type code.
<b>Title 21 Standard:</b>	California's compatibility specifications for a two way communications protocol for automatic vehicle identification including an initial set of transaction record codes for use in electronic toll collection applications.
<b>Transaction Record Type:</b>	A unique code that specifies the type of valid transaction between a reader and a transponder. This code is transmitted during the Reader Polling, Transponder Data and Reader Acknowledge messages and uniquely defines the function and information exchanged between the reader and transponder.
<b>Transponder:</b>	A typically portable electronic device that contains information which can be communicated to the reader. The transponders may have the capability to read and write information.
<b>Transponder Data Message:</b>	The second step in a half duplex communication scheme. Transponder provides the reader a specific response to a Transaction Record Type code transmitted during the Reader Polling Message.

**OVERVIEW OF PROTOCOL:**

The California Department of Transportation is providing the following *for informational purposes only*, and assumes *no liabilities* for errors and omissions contained within. It is recommended that you contact your Title 21 system provider to confirm capabilities and ensure that no proprietary implementations or design improvements compromise interoperability with other Title 21 systems.

The currently defined Title 21 protocol is a half duplex communication scheme where the transponder takes its cues from the reader in the following order:

1. Reader Polling Message
2. Transponder Data Message
3. Reader Acknowledge Message.

Each of these three stages of communication has three defined Message Types that further define the function and information exchanged between the reader and transponder.

For complete technical details of the communication protocol refer to this document and to:

- Barclays California Code of Regulations for the Title 21 standard for Reader and Transponder compatibility specifications
- California's Definition for Title 21's Transponder ID Number Field for interoperability assignments within the State.

An overview of this protocol consists of the following ordered bits:

**1. READER POLLING MESSAGE:**

TYPE	# BITS	DESCRIPTION	HEX VALUE
<b>1</b>	<b>12</b>	<b>Header</b>	<b>Always "AAC"</b>
	16	Transaction Record Type Code	Always "8000"
	16	Agency Code	Undefined
	16	Error Detection Code (CRC 16)	Dependent on Above
	<b>60</b>	<b>Total</b>	
<b>2</b>	<b>12</b>	<b>Header</b>	<b>Always "AAC"</b>
	16	Transaction Record Type Code	Currently Always "80xx"
	16	Agency Code	Undefined
	24	Encode Key (Encryption Proprietary to Texas Instruments)	Proprietary Implementation
	16	Error Detection Code (CRC 16)	Dependent on Above
	<b>84</b>	<b>Total</b>	
<b>3</b>	<b>12</b>	<b>Header</b>	<b>Always "AAC"</b>
	16	Transaction Record Type Code	Currently Always "88xx"
	<b>32</b>	Transponder ID Number	Defined in California and undefined everywhere else
	<b>24</b>	Encode Key (Encryption Proprietary Texas Instruments)	Proprietary Implementation
	8	Error Detection Code (CRC 16)	Dependent on Above
	<b>100</b>	<b>Total</b>	

**TRANSPONDER DATA MESSAGE:**

TYPE	# BITS	DESCRIPTION	HEX VALUE
<b>1</b>	12	Header	Always "AAC"
	16	Transaction Record Type Code	Always "0001"
	32	Transponder ID Number	Defined in California and undefined everywhere else
	16	Error Detection Code (CRC 16)	Dependent on Above
	<b>76</b>	<b>Total</b>	
<b>2</b>	12	Header	Always "AAC"
	16	Transaction Record Type Code	Currently Always "0007"
	128	Block A Data	System and User Defined
	16	Error Detection Code (CRC 16)	Dependent on Above
	<b>172</b>	<b>Total</b>	
<b>3</b>	12	Header	Always "AAC"
	16	Transaction Record Type Code	Currently Always "000x"
	128	Block A Data	System and User Defined
	128	Block B, C or D Data	System and User Defined
	16	Error Detection Code (CRC 16)	Dependent on Above
	<b>300</b>	<b>Total</b>	

**3. READER ACKNOWLEDGE MESSAGE:**

TYPE	# BITS	DESCRIPTION	HEX VALUE
1	12	Header	Always "AAC"
	16	Transaction Record Type Code	Always "C000"
	32	Transponder ID Number (Must Match Transmission)	Defined in California and undefined everywhere else
	32	Reader ID Number	Undefined
	16	Transaction Status Code	
	16	Error Detection Code	
	124	<b>Total</b>	
2	12	Header	Always "AAC"
	16	Transaction Record Type Code	Currently Always "C00x"
	16	Agency Code	Undefined
	32	Transponder ID Number (Must Match Transmission)	Defined in California and undefined everywhere else
	16	Reserved	Currently "00" Until Defined
	32	Reader ID Number	Undefined
	16	Transaction Status Code (Activates microprocessor if present when $\geq 8000$ )	Undefined
	16	Error Detection Code (CRC 16)	Dependent on Above
	156	<b>Total</b>	
3	12	Header	Always "AAC"
	16	Transaction Record Type Code	Currently Always "C00x"
	16	Agency Code	Undefined
	32	Transponder ID Number (Must Match Transmission)	Defined in California and undefined everywhere else
	16	Reserved	Currently "00" Until Defined
	32	Reader ID Number	Undefined
	16	Transaction Status Code (Activates microprocessor if present when $\geq 8000$ )	Undefined
	128	Data	Undefined
	16	Error Detection Code (CRC16)	Dependent on Above
	284	<b>Total</b>	

There are a number of undefined data elements within the above messages which are summarized as follows

**Reader Polling Message:**

- Transaction Record Type Code(s) – 16 Bits
- Agency Code(s) – 16 Bits

**Transponder Data Message:**

- Transaction Record Type Code(s) – 16 Bits
- Transponder ID Number (Currently defined only within California) – 32 Bits

**Reader Acknowledge Message:**

- Transaction Record Type Code(s) – 16 Bits
- Reader ID Number(s) – 32 Bits
- Transaction Status Code(s) – 16 Bits.

## APPROVED TRANSACTION RECORD TYPE CODES

Since Title 21 is an open standard, the functionality of all Approved Transaction Record Type Codes is available for manufacturers to develop interoperable products. However, in some cases (e.g. code functionality affecting account balance on transponders) additional institutional arrangements must be made to avoid potential liability. Please contact Caltrans for further information on developing interoperable products, or to request approval for new Transaction Record Type Codes.

The Caltrans approved Transaction Record Type codes are separated by half duplex communication stage and are summarized as follows:

HALF DUPLEX COMMUNICATION STAGE		TRANSACTION RECORD TYPE CODE (HEX)
1. Reader Polling Message*	25 Total	8000, 8001, 8002, 8003, 8004, 8010, 8011, 8012, 8013, 8014, 8020, 8021, 8022, 8023, 8024, 8030, 8031, 8032, 8033, 8034, 8800, 8801, 8802, 8803, 8804
2. Transponder Data Message*	5 Total	0001, 0002, 0003, 0004, 0007
3. Reader Acknowledge Message*	16 Total	C000, C001, C002, C003, C004, C005, C006, C007, C008, C009, C00A, C00B, C00C, C00D, C00E, C00F

\* Please note that with the exception of the interoperable messages 8000, 0001 and C000 the Transaction Record Type codes are specific Texas Instruments product implementations.